CUSTOMER NO. 46850 *PATENT*

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Re: Attorney Docket No. Kodialam 26-26-3

In re application of: Muralidharan Kodialam et al.

Serial No.:	10/776,466	Group Art Unit:	2616
Filed:	2/11/04	Examiner:	Andrew Lai
Matter No.:	990.0489	Phone No.:	571-272-9741

For: Traffic-Independent Allocation of Working and Restoration Capacity in Networks

APPELLANT'S BRIEF UNDER 37 CFR 41.37

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22213-1450

Dear Sir:

In response to the Final Office Action of January 9, 2008, and further to the Notice of Appeal filed April 8, 2008, Appellant/Applicant submits the following Appellant's Brief in support of the appeal:

APPELLANT'S BRIEF

1. REAL PARTY IN INTEREST

The real party in interest is Lucent Technologies Inc., assignee of all rights, title, and interest of the inventors.

2. RELATED APPEALS AND INTERFERENCES

There are no related appeals or interferences.

3. STATUS OF CLAIMS

Claims 1-19 are pending. The appealed claims are 1, 2, 5-7, 9, and 11. Claims 12-14 and 17-19 are allowed. Claims 4, 8, and 10 are indicated as allowable if rewritten in independent form. Claims 3, 15, and 16 are cancelled.

4. STATUS OF AMENDMENTS

No amendments were filed after the January 9, 2008, Final Office Action.

5. SUMMARY OF CLAIMED SUBJECT MATTER

The claimed subject matter, along with references to exemplary supporting portions of the specification, is set forth below:

Certain embodiments of the present invention relate to capacity allocation in a telecommunications network, and, more particularly, to allocation of working capacity and restoration capacity of links of the network (p. 1, lines 7-9).

In an interconnected communication network, users establish connections between a source node and a destination node of the network to transfer a stream of data, referred to as "traffic," through the network over a network path (p. 1, lines 11-14). A network path for a connection between a given source-destination (node) pair is defined by a set of nodes (the source and destination node pair and any intermediate nodes) interconnected by a set of links coupled to the nodes carrying the data stream, or flow, of the connection (p. 1, lines 17-20). Each node and each link has a capacity corresponding to the traffic it may carry, and the term "capacity" may be a general term describing bandwidth, effective bandwidth, link

quality, or similar link transmission characteristic (p. 1, lines 20-23).

A connection in a network might be protected at the path level or at the link level (p. 1, line 32). For link restoration (also often referred to as "local restoration" or as "fast restoration"), each link of the connection is protected by a set of pre-provisioned detour paths that exclude the link being protected (p. 2, lines 1-3). Upon failure of the link, traffic on the failed link is switched to the detour paths (p. 2, lines 3-4). Thus, link restoration provides a local mechanism to route around a link failure (p. 2, lines 4-5). In path restoration, the primary, or working, path of the connection is protected by a "diverse" backup path from source to destination (p. 2, lines 5-6). Upon failure of any of the resources on the working path, traffic is switched to the backup path by the source node (p. 2, lines 6-8). Link restoration might typically restore service much faster than path restoration because restoration is locally activated and, unlike path restoration, failure information need not propagate back through the network to the source (p. 2, lines 8-10).

Each link of a network has a corresponding capacity to transfer data, which link capacity is typically expressed as a link characteristic such as bandwidth or effective bandwidth (a quantity that takes into account transmission requirements such as buffer and/or transmission delay, packet loss, and Quality-of-Service guarantees) (p. 2, lines 11-14). This link capacity may be divided into working capacity and reservation capacity through network provisioning (p. 2, lines 14-15). Working capacity is the capacity of the link reserved for connections (traffic) under normal operating conditions, while reservation capacity is the capacity of the link employed for rerouting connections when a link, path, or node failure occurs within the network (p. 2, lines 16-19). For reservation capacity, several different restoration paths may commonly share the reservation capacity of a link (termed "shared reservation capacity usage") (p. 2, lines 19-20).

A given network is said to be edge bi-connected if the removal of any single link does not disconnect the network (p. 2, lines 28-29). Hence, for any link e between nodes i and j (i.e., $e = (i, j)$), a path B_e exists from node i to node j that does not include link e (p. 2, lines 29-30). In this scenario, for a first exemplary network, 50% of the capacity of every link might be reserved for working traffic, where all link capacities are equal (p. 2, line 30 – p. 3, line 1). Then, when a link e fails, its working traffic, which is at most 50% of the link's capacity, may be rerouted on detour B_e, because (i) every link on B_e has 50% of its capacity reserved for restoration traffic, and (ii) all link capacities are equal (p. 3, lines 1-4). Hence, for this exemplary network, 50% of the network capacity is reserved for restoration (p. 3, lines 4-5).

For a second exemplary network, edge connectivity of the network is 3 (i.e., at least 3 links must be removed to disconnect the network), where, again, all link capacities are equal (p. 3, lines 6-8). In this case, for any link $e = (i,j)$, two link disjoint paths B_e and $B_e^{'}$ exist from node i to node j that do not include

link e (p. 3, lines 8-9). Suppose that 2/3 (≈ 67%) of the capacity of every link is reserved for working traffic (p. 3, lines 9-10). Then, when a link e fails, half of its working traffic, which is at most 1/3 of the link capacity, may be rerouted on detour B_e, and the other half on detour $B_e^{'}$, since (i) every link on B_e and $B_e^{'}$ has 1/3 (i.e., 33%) of its capacity reserved for restoration traffic, (ii) detours B_e and $B_e^{'}$ are link disjoint, and (iii) all link capacities are equal (p. 3, lines 10-14).

As these two exemplary networks illustrate, edge connectivity of the network, the link capacities, and the required link working capacities can affect the allocation of capacity reserved for restoration (p. 3, lines 16-18).

Exemplary Embodiment

FIG. 1 shows an exemplary fixed-capacity reservation method **100** of partitioning network capacity in accordance with an exemplary embodiment of the present invention (p. 4, lines 23-24). As employed herein, the term "fixed-capacity" implies that the capacities of the links of the network after partitioning are fixed *a priori* (p. 4, lines 25-26). At step **101**, network topology information is generated for the network (p. 4, lines 26-27). The network topology information includes the nodes and the links between the nodes of the network (p. 4, lines 27-28). The network topology information also includes the capacity of the links between the nodes (p. 4, lines 28-29). Thus, the network may be modeled as a graph of nodes and links, where each link has an associated capacity, and each link may also have a corresponding link cost (p. 4, line 29 – p. 5, line 1). Assigning such cost is well-known in the art, and may be related to, for example, a guaranteed bandwidth or other quality of service (QoS) metric, importance of the link in the connectivity of the network, or actual monetary cost of the link (p. 5, lines 1-4).

At step **102**, constraints for the network are generated (p. 5, lines 1-4). In accordance with exemplary embodiments of the present invention, the fixed-capacity reservation method partitions the network into working capacity and restoration capacity (p. 5, lines 5-7). This partitioning of the network into working (also termed service) and restoration capacity is accomplished on a link-by-link basis (p. 5, lines 7-9). The total capacity (e.g., bandwidth or effective bandwidth) of each link in the network is partitioned into working capacity and restoration capacity so as to satisfy these network constraints: 1) guarantee that, for each link, a set of detour paths exists whose bandwidths sum to the working capacity of the link; 2) guarantee that, for each link, the sum of the working capacity and the shared capacity usage of the detour paths going through it is at most the total capacity of the link, and 3) maximize the working capacity of the network (i.e., sum of the working capacities of all links) (p. 5, lines 9-16).

At step **103**, the three network constraints are formulated as a linear programming problem (LPP)

(p. 5, lines 17-18). The LPP is a network design problem with the objective of maximizing the working capacity of the network under constraints 1) and 2) above (p. 5, lines 18-19). Thus, each link in the network is partitioned into working capacity and reservation capacity so as to maximize the working capacity of the network (i.e., the sum of the reserved working capacity on each link) (p. 5, lines 19-22). This network design problem does not assume any point-to-point traffic matrix, and hence, is traffic-independent (p. 5, lines 22-23). Constraints 1) and 2) above ensure that, when partitioning link bandwidth usage for the scheme, a portion of the bandwidth of each link has been reserved for working traffic and a set of detours computed whose bandwidths sum to the working capacity of the link (p. 5, lines 23-26).

At step **104**, either an exact solution or an approximation for the solution to the LPP is generated (p. 5, lines 27-28).

At step **105**, each link in the network is partitioned into the corresponding working capacity and restoration capacity values for the link as specified by the solution to the LPP generated in step **104** (p. 5, line 30 – p. 6, line 2). Such partitioning may typically be accomplished through network provisioning (p. 6, lines 1-2).

For link restoration when a link *e* (also termed an "edge") in a path *P* fails, each link of the connection in path *P* is protected by a detour path that excludes link *e* (p. 6, lines 3-4). Upon failure of link *e*, traffic on link *e* is switched to the detour path (p. 6, lines 4-5). At any given time, the variable r_e represents the residual working capacity of link *e*, and the variable b_e^i represents the residual capacity of the i^{th} detour for that link, and so $\sum_i b_e^i = r_e, \quad \forall e \in E$ (since the sum of the restoration bandwidths over the detour path must be equal to the working capacity being backed-up) (p. 6, lines 5-9). A demand (i.e., a request to route a connection) with bandwidth *b* may be routed on this link if $b \leq r_e$ and $b \leq \max_i b_e^i$. If $b_e^{\max} = \max_i b_e^i$, then $b_e^{\max} \leq r_e$ (p. 6, lines 9-11).

Independent Claim

The subject matter defined in the sole independent claim being appealed, along with references to exemplary supporting portions of the specification, is set forth below:

Claim 1 recites a method of partitioning capacity of a network into working capacity and restoration capacity. The method includes the steps of: (a) generating a set of network constraints for a network of nodes interconnected by links in accordance with a network topology, wherein the network constraints include: 1) for each link, a set of one or more detour paths exist whose capacities sum to the working capacity of the link; 2) for each link, the sum of the working capacity and the restoration capacity

shared by the set of one or more detour paths is, at most, a total capacity of the link; and 3) the working capacity of the network is maximized (p. 5, lines 5-16; p. 9, line 5 – p. 10, line 14); (b) formulating a linear programming problem (LPP) for the network topology based on the set of network constraints (p. 5, lines 17-26; p. 7, line 24 – p. 10, line 14; p. 11, line 7 – p. 12, line 3); and (c) generating either an exact or an approximate solution for the LPP, the solution including a working capacity and a restoration capacity of each link.of the network (p. 5, lines 27-29; p. 10, line 28 – p. 11, line 6)..

6. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

This appeal presents the issue of whether the rejections of claims 1, 2, 5, 6, and 11 under 35 U.S.C. 102(b) as being anticipated by U.S. Patent Application Pub. No. 2002/0071392 ("Grover"), the rejection of claim 7 under 35 U.S.C. 103(a) as being obvious over Grover in view of "Capacity design of Fast Path Restorable Optical Networks," *IEEE INFOCOM 2002*, p. 817-826 ("Hauser"), and the rejection of claim 9 under 35 U.S.C. 103(a) as being obvious over Grover in view of U.S. Patent No. 6,404,744 ("Saito") are proper.

7. ARGUMENT

Claims 1, 2, 5-7, 9, and 11 Are Patentable over the Cited References

Claim 1 recites:

1. A method of partitioning capacity of a network into working capacity and restoration capacity, the method comprising the steps of:

(a) generating a set of network constraints for a network of nodes interconnected by links in accordance with a network topology, wherein the network constraints include:

1) for each link, a set of one or more detour paths exist whose capacities sum to the working capacity of the link;

2) for each link, the sum of the working capacity and the restoration capacity shared by the set of one or more detour paths is, at most, a total capacity of the link; and

3) the working capacity of the network is maximized;

(b) formulating a linear programming problem (LPP) for the network topology based on the set of network constraints; and

(c) generating either an exact or an approximate solution for the LPP, the solution including a working capacity and a restoration capacity of each link of the network.

The network constraints specifically recited in claim 1 include: 1) for each link, a set of one or more detour paths exist whose capacities sum to the working capacity of the link; 2) for each link, the sum of the working capacity and the restoration capacity shared by the set of one or more detour paths is, at most, a total capacity of the link; and 3) the working capacity of the network is maximized.

In rejecting claim 1, the Examiner stated that Grover discloses the Applicant's constraint 2, namely, "for each link, the sum of the working capacity and the restoration capacity shared by the set of one or more detour paths is, at most, a total capacity of the link," citing to Grover's constraints (2) and (5), as set forth in paragraphs [0021] and [0022] of Grover. The Examiner argued that "since both constraints (2) and (5) must be met simultaneously, the combination of the two constraints ensures the claimed limitation." This conclusion is erroneous. There is a fundamental difference in the formulation in Grover and claim 1 of this patent application. The problem that is addressed in Grover is a **network-design problem**. The objective of the formulation is to design a network at minimum cost. There are **no capacity constraints** in the formulation. The objective function (constraint (1)) in Grover is merely the cost of designing the network. In contrast, in claim 1 of the present application, the Applicant assumes that the network is given and is a "fixed-capacity" network, i.e., the capacities of the links of the network after partitioning are fixed *a priori*, and the objective is to route the traffic (specification, p. 4, lines 23-26). Since the network is specified, in particular, since the link capacities are given, **the routing has to respect these link capacities**. It is not possible to convert a linear network design problem into one with capacities. Therefore, there is no way that combining Grover's constraints (2) and (5) can possibly yield Applicant's constraint 2.

Grover's constraint (2) is:

$$\sum_{q \in Q^r} g^{r,q} = d^r \qquad \forall\, r \in D$$

As explained in the reference table between paragraphs [0020] and [0021] of Grover, the variable $g^{r,q}$ represents working capacity assigned to the q^{th} eligible working route for demand pair r, and the variable d^r represents the number of demand units for O-D pair r. Therefore, Grover's constraint (2), which, according to Grover, "ensure[s] that all working demands are routed," essentially states that the working capacity for a given demand pair is equal to the demand for that pair.

Grover's constraint (5) is:

$$s_j \geq \sum_{p \in P_i} \delta^p_{i,j} \cdot f^p_i \qquad \forall\, (i,\, j) \in S \times S\colon\ i \neq j$$

As explained in the reference table between paragraphs [0020] and [0021] of Grover, the variable s_j represents the number of spare capacity units placed on span j, the variable $\delta^p_{i,j}$ has a value of 1 if the pth eligible route for restoration of span i uses span j and zero otherwise, and the variable f^p_i represents the restoration flow assigned to the pth eligible restoration route for span i. Therefore, Grover's constraint (5), which, according to Grover, "forces sufficient spare capacity on each span j such that the sum of the restoration paths routed over that span is met for failure of any span i," essentially states that the number of spare capacity units placed on span j is greater than or equal to the restoration flow for the restoration of span i.

While Grover's constraint (2) ensures that working capacity for a given demand pair is equal to the demand for that pair, and Grover's constraint (5) ensures that the number of spare capacity units placed on span j is greater than or equal to the restoration flow for the restoration of span i, no combination of these two constraints can possibly yield the Applicant's constraint 2, namely, that "for each link, the sum of the working capacity and the restoration capacity shared by the set of one or more detour paths is, at most, a total capacity of the link." Indeed, there is nothing in Grover's constraints (2) and (5) to ensure that the sum of working capacity and restoration capacity of a set of detour paths does not exceed link capacity. In other words, it is possible that both of Grover's constraints 2 and 5 can be satisfied, i.e., working capacity for a given demand pair equals demand for that pair, and a given span j has sufficient spare capacity units to handle restoration flow for span i, at the same time that the sum of working capacity and restoration capacity exceeds total link capacity, because there is no constraint in Grover to prevent this.

To the contrary, equation (8) of the Applicant's specification provides an example of the Applicant's constraint 2, as follows:

$$\sum_{P: P \in \mathrm{P}_e} f(P) + \sum_{P: P \in \mathrm{P}_f,\, e \in P} f(P) \leq u_e \qquad \forall\, f \neq e, \quad e, f \in E \qquad (8)$$

This constraint states that "the working capacity on link *e* plus the restoration capacity that appears on link *e* due to failure of link f ($f \neq e$) is at most the capacity u_e of link *e*" (specification, at p. 11, lines 9-12). The Examiner stated on page 11 of the January 9, 2008, Final Office Action that the "Examiner respectfully disagrees with the equating of Applicant's constraint 2 to said formula (8) because constraint 2 is with respect to both *working/restoration capacities* while formula (8) recites about only the *restoration traffic*"

(emphasis in original). However, this is a misinterpretation of Applicant's equation (8), because equation (8) not only represents restoration traffic via the expression $\sum_{P:P\in \mathrm{P}_f, e\in P} f(P)$, but also represents working capacity via the expression $\sum_{P:P\in \mathrm{P}_e} f(P)$. The expression $\sum_{P:P\in \mathrm{P}_e} f(P)$ is shown in equation (5) on page 9 of Applicant's specification as being equal to x_{ij}, which is defined as "the working capacity on link (i,j)," and "[a]mong the paths in the set P_{ij}, those that form the detour paths for link (i, j) have their $f(P)$ values sum to x_{ij}, as expressed in equation (5):

$$\sum_{P:P\in \mathrm{P}_{ij}} f(P) = x_{ij}, \qquad (5)"$$

(specification, at p. 9, lines 2-12).

Constraints (2) and (5) of Grover, even taken in combination, do not disclose any constraint involving a sum of both restoration traffic and working capacity, to ensure that the link capacity u_e of a link e is not exceeded, as required by claim 1. Nor do the other portions of Grover cited by the Examiner disclose such a constraint – there is simply no such constraint disclosed, taught, or even suggested in Grover. Since Grover does not disclose a network constraint wherein "for each link, the sum of the working capacity and the restoration capacity shared by the set of one or more detour paths is, at most, a total capacity of the link," Grover cannot anticipate claim 1.

In the March 28, 2008, Advisory Action, the Examiner attempted to show mathematically that combining Grover's constraints (2) and (5) allegedly results in the Applicant's constraint that, "for each link, the sum of the working capacity and the restoration capacity shared by the set of one or more detour paths is, at most, a total capacity of the link." However, this entire analysis is fundamentally flawed, because the analysis is based on an incorrect premise that has no support in Grover, namely, that "d^e is the working capacity of an O-D pair e." In making this incorrect statement, the Examiner cited to the table in paragraph [0020] of Grover. However, this table makes it clear that d^e is **NOT**, in fact, the working capacity of an O-D pair e, but rather, the "number of demand units of O-D pair [e]". Working capacity and number of demand units are not the same thing! This incorrect premise runs through all of the Examiner's calculations, and following this incorrect premise, the Examiner concluded that the Applicant's and Grover's formulations are the same, which, as fully discussed above, they are not.

It is elemental that, under 35 U.S.C. §102, "[a] claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir.

1987). Grover simply does not disclose a constraint that involves a sum of both restoration traffic and working capacity, to ensure that the link capacity u_e of a link e is not exceeded, as required by claim 1, and therefore Grover cannot anticipate claim 1.

For these reasons, the Applicant submits that claim 1 is novel over Grover, and the rejection of claim 1 as anticipated by Grover is clearly in error. Since claims 2, 5-7, 9, and 11 depend variously from claim 1, it is further submitted that those claims are also patentable over the cited references, and the rejections of those claims are also clearly in error.

F. Conclusion

For the foregoing reasons, Applicant requests that this appeal be sustained, that the pending rejections be reversed, and that all claims pending in the application be allowed.

Respectfully submitted,

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APPENDIX A

CLAIMS INVOLVED IN THE APPEAL

1. A method of partitioning capacity of a network into working capacity and restoration capacity, the method comprising the steps of:

(a) generating a set of network constraints for a network of nodes interconnected by links in accordance with a network topology, wherein the network constraints include:

1) for each link, a set of one or more detour paths exist whose capacities sum to the working capacity of the link;

2) for each link, the sum of the working capacity and the restoration capacity shared by the set of one or more detour paths is, at most, a total capacity of the link; and

3) the working capacity of the network is maximized;

(b) formulating a linear programming problem (LPP) for the network topology based on the set of network constraints; and

(c) generating either an exact or an approximate solution for the LPP, the solution including a working capacity and a restoration capacity of each link of the network.

2. The invention of claim 1, further comprising the step of (d) partitioning the capacity of each link of the network based on the solution for the LPP.

5. The invention of claim 1, wherein, for step (b), the LPP is a path-indexed LPP formulation.

6. The invention of claim 5, wherein step (c) further comprises the step of (c1) generating a dual of the path-indexed LPP formulation.

7. The invention of claim 6, wherein step (c) further comprises the step of (c2) approximating the solution with a $(1+\varepsilon)$ approximation algorithm.

9. The invention of claim 1, wherein, for step (b), the LPP is a link-indexed LPP formulation.

11. The invention of claim 1, wherein, for step (a), the network is either an electro-optical network or a packet-based network.

APPENDIX B

EVIDENCE

No evidence submitted pursuant to 35 U.S.C. §§ 1.130, 1.131, or 1.132 has been entered by the Examiner and relied upon by the Applicant in this appeal

APPENDIX C

RELATED PROCEEDINGS

There are no related proceedings.